We Claim:

1. A method for maintaining an accurate channel estimate, the method comprising:

providing a reference channel estimate based on at least one first symbol;

generating a frequency domain representation of a second symbol including a plurality of pilots;

tracking phase change in the plurality of pilots of the second symbol relative to pilots of the at least one first symbol to produce correction factors; and

adjusting the reference channel estimate based upon the correction factors.

2. The method of claim 1, wherein tracking phase change includes determining for each pilot in the second symbol an associated total amount of rotation relative to a corresponding pilot in the at least one first symbol.

3. The method of claim 2, wherein tracking phase change includes determining a least squares fit based on the associated total amount of rotation for each pilot in the second symbol.

4. The method of claim 3 wherein tracking phase change includes generating, based on the least squares fit, second correction factors.

5. The method of claim 3, wherein tracking phase change includes

determining a slope and a phase intercept based upon the least squares fit, and

wherein generating, based on the least squares fit, includes generating the second correction factors based upon subcarrier numbers, the phase intercept, and the slope.

6. The method of claim 5, wherein generating the frequency domain representation of the second symbol includes sampling the second symbol early by a certain number of samples, further comprising:

determining an expected slope based on the certain number of samples by which the second symbol is sampled early; and

determining based on the slope and the expected slope a timing adjustment.

7. The method of claim 3, wherein tracking phase change includes

determining a slope and a phase intercept based upon the least squares fit,

determining a filtered slope and a filtered phase intercept based on the slope and the phase intercept associated with the second symbol, and at least one other slope and at least one other phase intercept associated with at least one symbol other than the second symbol, and

wherein generating, based on the least squares fit, includes generating the second correction factors based upon subcarrier numbers, the filtered slope and the filtered phase intercept.

8. The method of claim 7, further comprising:

determining a filtered phase intercept for a reference symbol, wherein the reference symbol is separated from the second symbol by a certain number of symbols;

determining a residual frequency offset based upon the filtered phase intercept for the reference symbol, the filtered phase intercept for the second symbol, and the certain number of symbols.

9. The method of claim 8, wherein the reference symbol is a data symbol that is not separated from the at least one first symbol by any other data symbol.

10. The method of claim 8, wherein the reference symbol is the one of the at least one first symbol.

11. The method of claim 1, the method comprising:

producing, for each pilot in the second symbol whose magnitude is above a threshold, an associated total amount of rotation relative to a corresponding pilot in the at least one first symbol;

producing for one of the pilots in the second symbol total amount of rotation based on the associated total amount of rotation of other pilots in the second symbol;

determining a least squares fit based on the associated total amount of rotation for each pilot in the second symbol whose magnitude is above the threshold and the total amount of rotation based on the associated total amount of rotation of other pilots in the second symbol; and

generating, based on the least squares fit, the plurality of second correction factors.

12. The method of claim 11, wherein producing for one of the pilots includes producing for one of the pilots in the second symbol whose magnitude is below the threshold a total amount of rotation based on the associated total amount of rotation of other pilots in the second symbol.

13. A method for maintaining an accurate channel estimate, the method comprising:

providing a reference channel estimate based on at least one training training symbol;

generating a frequency domain representation of a first data symbol including a plurality of pilots;

tracking phase change in the plurality of pilots of the first data symbol relative to pilots of the at least one training training symbol to produce first correction factors; and

adjusting the reference channel estimate based upon the first correction factors.

14. The method of claim 13, wherein tracking phase change includes determining for each pilot in the first data symbol an associated total amount of rotation relative to a corresponding pilot in the at least one training symbol.

15. The method of claim 14, wherein tracking phase change includes determining a least squares fit based on the associated total amount of rotation for each pilot in the first data symbol.

16. The method of claim 15, wherein tracking phase change includes generating, based on the least squares fit, second correction factors.

17. The method of claim 15, wherein tracking phase change includes

determining a slope and a phase intercept based upon the least squares fit, and

wherein generating, based on the least squares fit, includes generating the second correction factors based upon subcarrier numbers, the phase intercept, and the slope.

18. The method of claim 17, wherein generating the frequency domain representation of the first data symbol includes sampling the first data symbol early by a certain number of samples, further comprising:

determining an expected slope based on the certain number of samples by which the first data symbol is sampled early; and

determining based on the slope and the expected slope a timing adjustment.

19. The method of claim 15, wherein tracking phase change includes

determining a slope and a phase intercept based upon the least squares fit,

determining a filtered slope and a filtered phase intercept based on the slope, the phase intercept, and at least one other slope and at least one other phase intercept associated with at least one symbol other than the first data symbol, and

wherein generating, based on the least squares fit, includes generating the second correction factors based upon subcarrier numbers, the filtered slope and the filtered phase intercept.

20. The method of claim 19, further comprising:

determining a filtered phase intercept for a reference symbol, wherein the reference symbol is separated from the first data symbol by a certain number of symbols;

determining a residual frequency offset based upon the filtered phase intercept for the reference symbol, the filtered phase intercept for the first data symbol, and the certain number of symbols.

21. The method of claim 20, wherein the reference symbol is a data symbol that is not separated from the at least one training symbol by any other data symbol.

22. The method of claim 20, wherein the reference symbol is one of the at least one training symbol.

23. The method of claim 13, the method comprising:

producing, for each pilot in the first data symbol whose magnitude is above a threshold,

an associated total amount of rotation relative to a corresponding pilot in the at least one training training symbol;

producing for one of the pilots in the first data symbol a total amount of rotation based on the associated total amount of rotation of other pilots in the first data symbol;

determining a least squares fit based on the associated total amount of rotation for each pilot in the first data symbol whose magnitude is above the threshold and the total amount of rotation based on the associated total amount of rotation of other pilots in the first data symbol; and

generating, based on the least squares fit, the plurality of second correction factors.

24. The method of claim 23, wherein producing for one of the pilots includes producing for one of the pilots in the first data symbol whose magnitude is below the threshold a total amount of rotation based on the associated total amount of rotation of other pilots in the first data symbol.

25. A method for maintaining an accurate channel estimate, the method comprising:

generating a frequency domain representation of at least one training training symbol;

determining a number of clock cycles that the at least one training symbol is sampled early;

generating first correction factors based on the number of clock cycles;

adjusting the frequency domain representation based upon the first correction factors to produce a reference channel estimate;

generating a frequency domain representation of a first data symbol;

tracking phase change in pilots of the first data symbol relative to pilots of the at least one training symbol to produce second correction factors; and

adjusting the reference channel estimate based upon the second correction factors.

26. The method of claim 25, wherein adjusting results in pilot signals in the frequency domain representation of the at least one training symbol having a substantially flat phase response.

27. The method of claim 25, wherein tracking phase change includes determining for each pilot in the first data symbol an associated total amount of rotation relative to a corresponding pilot in the at least one training symbol.

28. The method of claim 27, wherein tracking phase change includes determining a least squares fit based on the associated total amount of rotation for each pilot.

29. The method of claim 28, wherein tracking phase change includes generating, based on the least squares fit, the second correction factors.

30. The method of claim 28, wherein tracking phase change includes

determining a slope and a phase intercept based upon the least squares fit, and

wherein generating, based on the least squares fit, includes generating the second correction factors based upon subcarrier numbers, the phase intercept, and the slope.

31. The method of claim 30, wherein generating the frequency domain representation of the first data symbol includes sampling the first data symbol early by a certain number of samples, further comprising:

determining an expected slope based on the certain number of samples by which the first data symbol is sampled early; and

determining based on the slope and the expected slope a timing adjustment.

32. The method of claim 28, wherein tracking phase change includes

determining a slope and a phase intercept based upon the least squares fit,

determining a filtered slope and a filtered phase intercept based on the slope, the phase intercept, and previous slopes and previous phase intercepts associated with data symbols that arrived before the first data symbol, and

wherein generating, based on the least squares fit, includes generating the second correction factors based upon subcarrier numbers, the filtered slope and the filtered phase intercept.

33. The method of claim 32, further comprising:

determining a filtered phase intercept for a reference symbol, wherein the reference symbol is separated from the first data symbol by a certain number of symbols;

determining a residual frequency offset based upon the filtered phase intercept for the reference symbol, the filtered phase intercept for the first data symbol, and the certain number of symbols.

34. The method of claim 33, wherein the reference symbol is a data symbol that is not separated from the at least one training symbol by any other data symbol.

35. The method of claim 33, wherein the reference symbol is the one of the at least one training symbol.

36. The method of claim 25, the method comprising:

producing, for each pilot in the first data symbol whose magnitude is above a threshold, an associated total amount of rotation relative to a corresponding pilot in the at least one training symbol;

producing for one of the pilots in the first data symbol a total amount of rotation based on the associated total amount of rotation of other pilots in the first data symbol;

determining a least squares fit based on the associated total amount of rotation for each pilot in the first data symbol whose magnitude is above the threshold and the total amount of rotation based on the associated total amount of rotation of other pilots in the first data symbol; and

generating, based on the least squares fit, the plurality of second correction factors.

37. A method for maintaining an accurate channel estimate, the method comprising:

generating a frequency domain representation of at least one training symbol;

determining number of clock cycles that the at least one training symbol is sampled early;

generating a plurality of first correction factors based on the number of clock cycles;

wherein adjusting results in pilot signals in the frequency domain representation of the at least one training symbol having a substantially flat phase response

adjusting the frequency domain representation based upon the plurality of first correction factors to produce a reference channel estimate;

generating a frequency domain representation of a first data symbol;

tracking phase change in pilots of the first data symbol relative to the at least one training symbol to produce second correction factors;

wherein tracking phase change includes determining for each pilot in the first data symbol an associated total amount of rotation relative to a corresponding pilot in the at least one training symbol, determining a least squares fit based on the associated total amount of rotation for each pilot, and generating, based on the least squares fit, the second correction factors; and

adjusting the reference channel estimate based upon the second correction factors.

38. A method for maintaining an accurate channel estimate, the method comprising:

generating a frequency domain representation of at least one training symbol;

determining number of clock cycles that the at least one training symbol is sampled early;

generating a plurality of first correction factors based on the number of clock cycles;

wherein adjusting results in pilot signals in the frequency domain representation of the at least one training symbol having a substantially flat phase response

adjusting the frequency domain representation based upon the first correction factors to produce a reference channel estimate;

generating a frequency domain representation of a first data symbol;

tracking phase change in pilots of the first data symbol relative to pilots in the at least one training symbol to produce second correction factors;

wherein tracking phase change includes determining for each pilot in the first data symbol an associated total amount of rotation relative to a corresponding pilot in the at least one training symbol, determining a least squares fit based on the associated total amount of rotation for each pilot, generating, based on the least squares fit, the second correction factors, determining a slope and phase intercept based upon the least squares fit, and wherein generating, based on the least squares fit, includes generating the second correction factors based upon subcarrier numbers, the phase intercept, and the slope; and

adjusting the reference channel estimate based upon the second correction factors.

39. An apparatus for maintaining an accurate channel estimate, the apparatus comprising:

a frequency domain transform unit that is to generate a frequency domain representation of at least one training symbol and a frequency domain representation of a first data symbol;

an early sampling detection circuit that is to determine, based on the frequency domain representation of the at least one training symbol, number of clock cycles that the at least one training symbol is sampled early;

an angle-to-vector converter that is to produce a plurality of first correction factors based on the number of clock cycles;

a first multiplier that is to adjust the frequency domain representation based upon the first correction factors to produce a reference channel estimate;

a pilot phase tracking circuit that is to track total phase rotation in pilots of the first data symbol relative to pilots in the at least one training symbol to produce a plurality of second correction factors; and

a second multiplier that is to adjust the reference channel estimate based upon the plurality of second correction factors.

40. The apparatus of claim 39, wherein the pilot phase tracking circuit is to determine for each pilot in the first data symbol an associated total amount of rotation relative to a corresponding pilot in the at least one training symbol.

41. The apparatus of claim 39, wherein pilot signals in the reference channel estimate have a substantially flat phase response.

42. The apparatus of claim 41, wherein the pilot phase tracking circuit is to determine a least squares fit based on the associated total amount of rotation for each pilot.

43. The apparatus of claim 42 wherein the pilot phase tracking circuit generates, based on the least squares fit, the plurality of second correction factors.

44. The apparatus of claim 43, wherein the pilot phase tracking circuit determines a slope and

a phase intercept based upon the least squares fit, and generates the plurality of second correction factors based upon subcarrier numbers, the phase intercept, and the slope.

45. The apparatus of claim 44, wherein the frequency domain representation of the first data symbol is based on sampling the first data symbol early by a certain number of samples, and wherein the pilot phase tracking circuit determines an expected slope based on the certain number of samples by which the first data symbol is sampled early, and determines based on the slope and the expected slope a timing adjustment.

46. The apparatus of claim 42, wherein the pilot phase tracking circuit determines a slope and a phase intercept based upon the least squares fit, determines a filtered slope and a filtered phase intercept based on the slope, the phase intercept, and previous slopes and previous phase intercepts associated with data symbols that arrived before the first data symbol, and generates the plurality of second correction factors based upon subcarrier numbers, the filtered slope and the filtered phase intercept.

47. The apparatus of claim 46 wherein the pilot phase tracking circuit determines a filtered phase intercept for a reference symbol, wherein the reference symbol is separated from the first data symbol by a certain number of symbols and determines a residual frequency offset based upon the filtered phase intercept of the reference symbol, the filtered phase intercept of the first data symbol, and the certain number of symbols.

48. The apparatus of claim 47, wherein the reference symbol is a data symbol that is not separated from the at least one training symbol by any other data symbol.

49. The apparatus of claim 47, wherein the reference symbol is the one of the at least one training symbol.

50. The apparatus of claim 42, wherein the pilot phase tracking circuit is to produce, for each pilot in the first data symbol whose magnitude is above a threshold, an associated total amount of rotation relative to a corresponding pilot in the at least one training symbol, produce for one of

the pilots in the first data symbol a total amount of rotation based on the associated total amount of rotation of other pilots in the first data symbol, determine a least squares fit based on the associated total amount of rotation for each pilot in the first data symbol whose magnitude is above the threshold and the total amount of rotation based on the associated total amount of rotation of other pilots in the first data symbol, and generate, based on the least squares fit, the plurality of second correction factors.

51. An apparatus for maintaining an accurate channel estimate, the apparatus comprising:

a frequency domain transform unit that is to generate a frequency domain representation of at least one training symbol and a frequency domain representation of a first data symbol;

an early sampling detection circuit that is to determine, based on the frequency domain representation of the at least one training symbol, number of clock cycles that the at least one training symbol is sampled early;

an angle-to-vector converter that is to produce a plurality of first correction factors based on the number of clock cycles;

a first multiplier that is to adjust the frequency domain representation based upon the first correction factors to produce a reference channel estimate;

a pilot phase tracking circuit that is to determine for each pilot in the first data symbol an associated total amount of rotation relative to a corresponding pilot in the at least one training symbol, is to determine a least squares fit based on the associated total amount of rotation for each pilot, and is to produce a plurality of second correction factors; and

a second multiplier that is to adjust the reference channel estimate based upon the plurality of second correction factors.

52. An apparatus for maintaining an accurate reference channel estimate, the apparatus comprising:

a memory that stores the reference channel estimate;

a pilot phase tracking circuit that is receive pilots of at least one training symbol and pilots of a first data symbol and is to determine for a plurality of the pilots in the first data symbol an associated total amount of rotation relative to a corresponding pilot in the at least one training symbol, is to determine a least squares fit based on the associated total amount of

rotation for each pilot of the plurality of the pilots in the first data symbol, and is to produce a plurality of first correction factors based on the least squares fit; and

a second multiplier that is to adjust the reference channel estimate based upon the plurality of first correction factors.

53. The apparatus of claim 52, wherein the pilot phase tracking circuit determines a slope and a phase intercept based upon the least squares fit, and generates a plurality of second correction factors based upon subcarrier numbers, the phase intercept, and the slope.

54. The apparatus of claim 53, wherein the first data symbol has a first data symbol frequency representation that is based on sampling the first data symbol early by a certain number of samples, and wherein the pilot phase tracking circuit determines an expected slope based on the certain number of samples by which the first data symbol is sampled early, and determines based on the slope and the expected slope a timing adjustment.

55. The apparatus of claim 52, wherein the pilot phase tracking circuit determines a slope and a phase intercept based upon the least squares fit, determines a filtered slope and a filtered phase intercept based on the slope, the phase intercept, and previous slopes and previous phase intercepts associated with data symbols that arrived before the first data symbol, and generates the plurality of second correction factors based upon subcarrier numbers, the filtered slope and the filtered phase intercept.

56. The apparatus of claim 55 wherein the pilot phase tracking circuit determines a filtered phase intercept for a reference symbol, wherein the reference symbol is separated from the first data symbol by a certain number of symbols and determines a residual frequency offset based upon the filtered phase intercept of the reference symbol, the filtered phase intercept of the first data symbol, and the certain number of symbols.

57. The apparatus of claim 56, wherein the reference symbol is a data symbol that is not separated from the at least one training symbol by any other data symbol.

58. The apparatus of claim 56, wherein the reference symbol is the one of the at least one training symbol.

59. The apparatus of claim 52, wherein the pilot phase tracking circuit is to produce, for a plurality of pilots in the first data symbol whose magnitude is above a threshold, an associated total amount of rotation relative to a corresponding pilot in the at least one symbol, produce for one of the pilots in the first data symbol a total amount of rotation based on the associated total amount of rotation of other pilots in the first data symbol, determine a least squares fit based on the associated total amount of rotation for each pilot in the first data symbol whose magnitude is above the threshold and the total amount of rotation based on the associated total amount of rotation of other pilots in the first data symbol, and generate, based on the least squares fit, the plurality of second correction factors.

60. A method for maintaining an accurate channel estimate, the method comprising:

providing a reference channel estimate based upon at least one training symbol;

calculating a reference power based upon pilots of the at least one training symbol;

calculating a data symbol power based upon pilots of a data symbol;

determining a scaling factor based upon the reference power and the data symbol power; and

scaling the reference channel estimate based upon the scaling factor.

61. The method of claim 60, further comprising:

filtering the data symbol power to produce a filtered data symbol power; and

determining the scaling factor based upon the filtered data symbol power.

62. An apparatus for maintaining an accurate channel estimate, the apparatus comprising:

memory for storing a reference channel estimate based upon at least one training symbol;

a magnitude tracking circuit that is to calculate a reference power based upon pilots of the at least one training symbol and a data symbol power based upon pilots of a data symbol, and is to calculate a scaling factor based upon the reference power and the data symbol power; and

a multiply unit that is to scale the reference channel estimate based upon the scaling factor.

63. The apparatus of claim 62, wherein the magnitude tracking circuit is to filter the data symbol power to produce a filtered data symbol power and is to calculate the scaling factor based upon the filtered data symbol power.